SOIL SURVEY OF THE GRAND JUNCTION AREA, COLORADO.

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LOCATION AND BOUNDARIES OF THE AREA.

The Grand Valley lies to the westward of the great central ridge of the Rocky Mountains. The whole plateau region, of which this valley is so small a part, is commonly called "the western slope." Grand River, which has carved the valley through this high plateau region, is a tributary of the Colorado River. The valley is situated near the central-western part of the State of Colorado, and is all in Mesa County, of which Grand Junction is the county seat. Only a part of the valley is covered by the present survey.

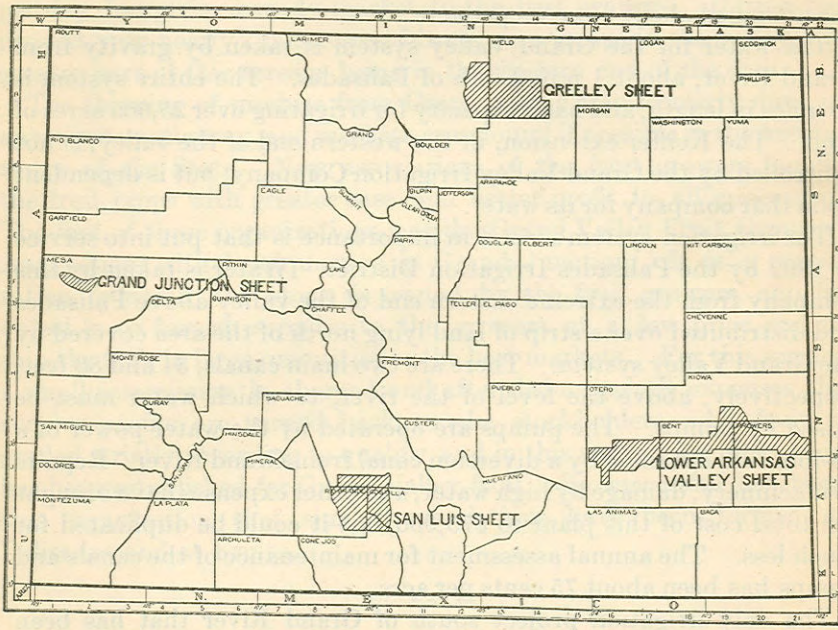

FIG. 41.—Sketch map showing location of the Grand Junction area, Colorado.

HISTORY OF SETTLEMENT AND AGRICULTURAL DEVELOPMENT.

The agricultural resources of Grand Valley were but slightly developed before 1882, as the country had no railroad communication with the outside world, and the necessary irrigation was practiced only on

small tracts near the river. In 1882 the Denver and Rio Grande Railroad was extended to Grand Junction, and the first steps were taken to construct a large irrigation system to bring under cultivation the arid lands of the valley. The main line of the Grand Valley Canal was completed by 1884, and the high line lateral, the Mesa County Ditch, and the Ranchman's Independent Ditch were well under way. After several changes of ownership all these canals passed into the hands of a single company controlled by the Travelers Insurance Company. Corporation management did not prove a success, and in 1894, the company having become involved in legal and financial complications, the entire canal system was sold to its water users, who have since operated it under the title of the Grand Valley Cooperative Association, the stock being owned by the farmers, each in proportion to the amount of water required to irrigate his land. As it has never been necessary to economize on water in Grand Valley, 1 miner's inch, or 1.56 cubic feet, per minute, has been allowed the owner to irrigate 2 acres of land. Since organization the affairs of the company have been well managed, and general satisfaction has prevailed among the water users. The annual assessment for running expenses and repairs has averaged about 65 cents per acre.

The water for the Grand Valley system is taken by gravity from Grand River, about 1 mile south of Palisades. The entire system is 46 miles in length, and has a capacity for irrigating over 25,000 acres of land. The Keiffer extension, in the western end of the valley, is not controlled by the Grand Valley Irrigation Company, but is dependent upon that company for its water.

The irrigation system second in importance is that put into service in 1892 by the Palisades Irrigation District. Water is taken by this company from the extreme eastern end of the valley above Palisades and distributed over a strip of land lying north of the area covered by the Grand Valley system. There are two main canals, 34 and 80 feet, respectively, above the level of the river, to which water must be raised by pumps. The pumps are operated by the water power of a 16-foot fall, obtained by a diversion canal from Grand River. Repairs to machinery, damage by high water, and other expenses have brought the total cost of this plant to $75,000, but it could be duplicated for much less. The annual assessment for maintenance of the canals and pumps has been about 75 cents per acre.

The only irrigation project south of Grand River that has been entirely successful is the small canal used to irrigate the river bottom opposite the town of Palisades. Water is lifted 26 feet by a 50-horsepower steam engine. The fuel used is waste coal from the mine near at hand, which is obtained at a very small cost. The capacity of the plant is 650 standard inches, or sufficient to irrigate four times the amount of land under the canal.

Several attempts have been made to bring a large part of Orchard Mesa, on the south side of Grand River, under cultivation, but only one small canal is at present in operation, and it is not entirely successful. This, commonly known as the Smith Canal, is fed by a pumping plant operated by water power. Delays on account of high water and for repairs of machinery have caused crops to suffer in several instances. There is no doubt, however, that a large part of Orchard Mesa will be successfully irrigated as land becomes more valuable.

The whole of Grand Valley, now under cultivation, was originally public land taken up by settlers in 160-acre tracts under the homestead law. Fruits and alfalfa became the principal crops of the early settlers, and grains and vegetables were grown for local use. The valley gradually became occupied, and land prices rose slowly but steadily until within the last few years, during which the remarkable profits of the fruit growers have caused a rapid increase in the values of all lands suited to fruit. As the markets for produce have widened new crops have been grown. The beet-sugar factory located at Grand Junction, with a capacity of 500 tons of beets per day, has given a ready market to the beet growers. During the present year nearly 7,000 acres of beets were grown in the valley, the greater part of this acreage being in the western end of the area.

The shipping of produce from Grand Valley was formerly done in an unsystematic way, and markets were found if possible in the mining towns of the State. Now associations of the fruit growers handle the fruit crops with greater ease and better profit to all concerned. The first of these organizations was the Grand Valley Fruit Growers' Association, with headquarters at Grand Junction. It is a corporation in which the stock is owned by the fruit growers, and its object is to furnish supplies to the growers at a low price and to ship the fruit in large quantities to the best markets. For this service a small commission is charged and after deducting all expenses the surplus profits are turned back to the stockholders. All fruit is graded strictly according to quality, and in this way a high reputation has been established for Grand Valley fruit. So successful has been this organization that similar associations have been formed at Palisades and at Fruita.

CLIMATE.

The climate of the valley as a whole is arid, with marked seasonal ranges of temperature. The topographic features have a great influence upon the occurrence of killing frosts in different parts of the valley, and therefore determine largely the kind of crop to be grown. Especially is this true of fruit, which is the principal industry of the valley. In the season of 1905 some parts of the valley had an excel-

lent crop of peaches, while in other parts the trees were totally devoid of fruit. This question of local climatic conditions has not received the study that is necessary to determine definitely its significance, but the experience of peach growers has been that in the vicinity of Palisades there have as yet been no freezes to kill the buds. Along the northern edge of the valley there is a high, precipitous ridge that extends from the eastern limits of the valley to about 5 miles west of Palisades. In the area between this ridge or bluff and the river bottoms the people have no fear of a failure of the peach crop.

Winter temperatures often go below zero throughout the valley, and in summer the thermometer often registers 85° to 90° F. in the shade. Compared to other parts of Colorado the summers are warm, but owing to the dryness of the atmosphere but little discomfort is experienced from high temperatures.

Strong winds occasionally sweep across the valley, but destructive storms of any kind are unknown. The rainfall is slight and is not relied upon in any way as a supplement to irrigation in the growing of crops.

The following tables give the dates of the first and last killing frosts in fall and spring and the mean annual temperature and precipitation as taken from the Weather Bureau records for the stations at Grand Junction and Collbran:

Dates of first and last killing frosts.

Year.	Grand Junction.		Collbran.	
	Last in spring.	First in fall.	Last in spring.	First in fall.
1897	Apr. 12	Oct. 27		
1898	Apr. 5	Oct. 17		
1899	Apr. 19	Oct. 16		
1900	Mar. 28	Oct. 21		
1902	Mar. 27	Nov. 2	June 3	Sept. 29
1903	Mar. 3	Oct. 31	May 23	Sept. 10
1904	Apr. 8	Nov. 5	May 29	Oct. 3
Average	Apr. 1	Oct. 26	May 29	Sept. 24

Normal monthly and annual temperature and precipitation.

Month.	Grand Junction.		Collbran.	Month.	Grand Junction.		Collbran.
	Temperature.	Precipitation.	Precipitation.		Temperature.	Precipitation.	Precipitation.
	°F.	Inches.	Inches.		°F.	Inches.	Inches.
January	27.0	0.61	0.98	August	75.6	1.15	1.31
February	31.3	.59	1.44	September	67.2	.93	1.02
March	42.8	.83	1.68	October	52.8	1.16	1.06
April	53.2	.66	1.29	November	40.1	.63	.94
May	61.6	.63	1.12	December	27.8	.41	1.18
June	71.8	.35	.65				
July	77.8	.55	1.11	Year	52.4	8.50	13.78

PHYSIOGRAPHY AND GEOLOGY.

Grand Valley has been carved out of a high plateau region of sedimentary rocks. The valley proper is considered as comprising all the lands north of the river that lie below the more or less well-defined mesa, along which flows the upper lateral of Grand Valley Canal, and a few very small areas occurring in bends south of the river. For the most part the river on its south side skirts a steep bluff which rises to a height of from 150 to 200 feet. The valley to the north of the river, between the river and the mesa on the north, is marked by several more or less well-defined bluffs, which in places are 25 to 50 feet in height. The most notable of these form the northern boundary of the large area of Laurel sandy loam just west of Grand Junction. The surface of the valley in some places has a grade of fully 100 feet to the mile. As a rule, however, the surface is nearly level, requiring no great amount of labor to prepare it for irrigation. North of the valley proper much of the Mesa fine sandy loam has a smooth surface, while other areas are very rough and broken, often to such an extent that irrigation would be very difficult.

Grand River enters the area in the extreme eastern end of the sheet and skirting the south side of the valley flows in a direction a little south of west to its confluence with the Gunnison River at the town of Grand Junction. Here it turns in a nearly northwesterly direction, which general course it keeps to the western limits of the survey.

East of the Gunnison and south of the Grand River, in sections 28, 29, and 30, T. 1 S., R. 1 W., and in sec. 25, T. 1 S., R. 2 W., there is some comparatively level land. The remainder of Orchard Mesa—that part of the bench lands south of Grand River and east of Gunnison River—is rolling, and in some instances rough, so much so as to be difficult to prepare for irrigation. West of the Gunnison River, on the south side of the Grand River, is a small area of bottom land and quite a large area of rolling bench lands that could be irrigated if water were supplied.

As has been before stated, the whole region is one of sedimentary rocks. Near Palisades, on the northern side of the area, the bluffs rise almost perpendicularly for nearly 1,000 feet. The capping is of a reddish sandstone, with the underlying material a blue carboniferous shale. Coal measures are found throughout this shale, and a number of mines are now worked. About 5 miles west of Palisades this bluff bends and extends to the northwest. Due north from Grand Junction the bluffs are 12 miles distant and are known as Bookcliffe Range. The mesas on each side of the river are the remnants of an old flood plain and are composed of material deposited by the river at some earlier time. In a few instances this flood plain is so eroded as to form hills of the sandy loam soil. Shaly areas exist wherever the sandstone

or this overlying capping of alluvium has been worn completely away, and shale also underlies all the mesa soil to the south of the river. Just across the river from Grand Junction a coal mine has been opened that supplies a fair grade of soft coal.

SOILS.

The soils of Grand Valley are made up almost wholly of material derived from sedimentary rock formations, the only exception being those soils that have been deposited from the waters of Grand River, which reaches back into granitic and volcanic regions to the east. A wide range occurs from the alluvial soils that are now being deposited by the river, or directly traceable to it, to the strictly residual soils along the foothills.

The following table gives the name and extent of each type of soil found in the area:

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Mesa fine sandy loam	34,432	32.1	Laurel fine sand	3,008	2.9
Billings fine sandy loam	26,944	25.1	Mesa clay loam	2,240	2.0
Mesa clay	22,464	20.9	Billings clay	1,664	1.5
Billings silt loam	5,632	5.3	Fruita loam	512	.4
Fruita fine sandy loam	3,968	3.7	Total	107,264	
Billings clay loam	3,328	3.1			
Laurel sandy loam	3,072	3.0			

LAUREL FINE SAND.

The Laurel fine sand is a loose, reddish-brown, friable, easily cultivated sand of medium to fine texture, ranging in depth from 1 to 6 feet. The subsoil consists of rounded and worn river gravel. Often this gravel is mixed with the soil, thus forming a very gravelly phase of the type.

Immediately along Grand River from Palisades to the western extremity of the area the Laurel fine sand occupies long, narrow strips of the low bottoms and is often subject to erosion in time of high water. Except for small channels and abandoned stream beds existing as sloughs or bayous, the surface is comparatively level, and this land may be placed under irrigation with little labor.

The loose, open, porous nature of the soil insures the ready penetration and leaching of water, and if the type were not so low lying it would have excellent drainage. A part of this type, however, suffers from seepage from the higher areas.

The Laurel fine sand is an alluvial soil of comparatively recent deposition. It is difficult to detect the presence of even small quantities of silt or clay in the sediments, the soil being made up almost

wholly of particles larger than 0.1 millimeter in diameter. As the river has shifted it has deposited these particles, which come partly from granitic and volcanic regions on the headwaters of the river and partly from the weathering of sandstones near the area. The gravel shows excellent specimens of granite and volcanic rock, as well as rounded fragments of sandstone.

Small areas of this soil show a brownish discoloration from decaying organic matter, but the major part of the type is deficient in humus and requires fertilization with some organic manure to produce good crops. Areas affected by seepage show an accumulation of alkali salts at the surface, but such accumulation is not yet pronounced, and should be greatly lessened by a little heavy flooding in irrigation.

The principal crops grown are the garden truck crops. A few of the earlier settlers planted fruit trees. In many instances these are now injured by seepage, though when not so injured they are doing well.

The Laurel fine sand is best adapted to truck crops, and large yields of these are usually secured.

The following table gives the results of a mechanical analysis of a sample of the fine earth of the soil of this type:

Mechanical analysis of Laurel fine sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
13427	Soil	0.0	1.1	5.3	62.0	20.3	8.2	3.2

LAUREL SANDY LOAM.

The Laurel sandy loam is a brown, friable, easily cultivated sandy loam, 2 to 6 feet deep, underlain by sand or gravel. Where the sand occurs it is in turn underlain by gravel, which is rarely more than 10 feet from the surface. The underlying sand is of the same texture, color, and general nature as the Laurel fine sand, while the gravel is similar to the river gravel now found in the stream bed. In occasional patches and ridges the gravel reaches the surface and forms small patches of a gravelly phase of the soil. In a few small areas representing the position of old stream beds the soil is of a slightly heavier nature and should be classified as a light loam.

Old stream beds and sloughs tend to make the surface slightly uneven, but are not a serious difficulty in the preparation of the lands for irrigation.

The soil is leachy and allows the ready percolation of water; but because of its low-lying position, often being bounded by bluffs from 6 to 20 feet high, much of it now suffers from seepage, due to irrigation upon the higher levels.

The Laurel sandy loam has all been deposited from the waters of the river as it has shifted its bed, and like the Laurel fine sand is composed of a mixture of particles coming from the disintegration of sandstone, granite, and volcanic rocks. The soil is fairly productive and contains considerable organic matter derived from the decay of vegetation which covered the soil prior to cultivation.

Wherever seepage water has neared the surface or the soil has become water-logged alkali is rapidly accumulating, and much of the type in such areas is even now so badly impregnated that crops are injured and in some instances cultivation wholly precluded. The most notable area thus ruined lies just west of the town of Grand Junction, where a tract of about 200 acres, once highly productive, has been practically abandoned, much of it being in the condition of a swamp.

The Laurel sandy loam is peculiarly adapted to the growing of truck crops, and, where the water table is not too close to the surface, to fruit trees, either apple, peach, or pear. Berries and the smaller fruits are a marked success. Sugar beets yield well, and alfalfa, if the water table be below 4 feet, is a very successful crop. Truck crops and berries, however, are best suited to this soil, and, as they are more valuable than the other crops, should be grown wherever marketing facilities will permit.

The following table gives the results of a chemical analysis of this soil:

Mechanical analysis of Laurel sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
13428	Soil	0.0	0.3	0.8	15.9	29.8	40.9	12.3

BILLINGS FINE SANDY LOAM.

The Billings fine sandy loam is a light-gray to brown fine sandy loam, 6 feet or more in depth. In some instances an imperfect stratification is discernible, showing alternate beds that vary in texture from a heavy fine sandy loam to almost a fine sand, but as a rule practically the same texture obtains to a depth of more than 6 feet. When moist the soil is friable and easily cultivated, but when dry tends to bake and if worked in such condition breaks up in large hard clods and is difficult to restore to good tilth.

Nearly all of this type of soil has a peculiar tendency to settle when irrigation water is applied, the total amount of settling often being 4 or more feet. Sometimes a season's thorough irrigation is sufficient to accomplish all the settling, but often the soil continues to settle for four or five years. The settling is not always uniform, but may occur

only in patches, so that much work is often necessary in scraping down high places and filling in the low ones before the soil reaches its ultimate level. This settling must be due to some peculiarity of structure, as no relation can be traced between the settling and the alkali content or other obvious characteristics.

The Billings fine sandy loam is the principal soil of the valley from Palisades to near Fruita, being situated between the mesa soils and the soils deposited immediately along the stream bed. In the main, the surface is a broad, smooth plain. The fall toward the river ranges from about 10 to more than 100 feet per mile. Wherever small intermittent streams cross from the north on their way to the river, deep, and in some instances wide, gullies have been eroded. These have perpendicular banks, but are not a serious drawback to cultivation. Several waste ditches from the large irrigating canal have been made along land subdivisions to the river. Where not provided with frequent checks and drops, these ditches have cut gullies from 8 to 15 feet deep, but they are quite narrow and are an advantage, inasmuch as they furnish drainage ways.

The drainage features of this soil are good. The supply of water, however, being more than sufficient, the farmers of the valley have used it excessively, so that at the present time parts of the soil are suffering from seepage.

The Billings fine sandy loam has been formed by the reworking of material derived from the shale and sandstone formations in the northern part of the area, with admixtures from the mesa soils. It has been deposited through the agency of small streams which rise to the north and flow across the valley.

The shale hills to the north all contain alkali, and as the soil material has been derived partly from this formation, it is to be expected that alkali will be found in the soil, and in its virgin condition much of it contains alkali in varying quantities. Its leachy nature and generally well-drained condition, however, usually result in the salts being almost wholly washed out after a few years of cultivation. The alkali areas, as shown upon the map, are nearly all virgin soil. The soil seems, in general, to be naturally productive, and crops so far have required but little fertilization.

Because of its deep, uniform, friable nature, the Billings fine sandy loam is preeminently adapted to the growing of fruit trees, alfalfa, and sugar beets. Upon it are planted nearly all the peach trees of the great Palisades peach belt. Farther west many apple orchards are in excellent condition. It is usually necessary to thin the fruit on the trees in order that they may be able to carry the load. Hundreds of acres are producing excellent crops of alfalfa. The alfalfa yields three crops each year, which give a total of 4 to 6 tons per acre.

Potatoes and other truck crops, grain, corn, and berries do well. Sugar beets are a paying crop, yielding from 10 to 15 tons per acre.

The following table gives the results of a mechanical analysis of a typical sample of this type of soil:

Mechanical analysis of Billings fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
13437	Soil	0.1	0.6	0.8	11.0	40.0	32.1	15.7

BILLINGS CLAY LOAM.

The Billings clay loam is a light-gray to dark-brown, sticky, plastic, compact loam, hard when dry, and difficult to cultivate. It varies from 4 to 6 feet or more in depth, and in the shallower depths is underlain by clay or clay loam of slightly darker color. The soil in general appearance is similar to the Billings fine sandy loam, but on closer examination it is seen to be heavier, the clay content being quite marked. It occupies an intermediate position between the Billings fine sandy loam and Billings silt loam or clay and occurs only in a few areas in the valley. The surface is generally smooth and level and needs but little preparation for irrigation. Except for a few gullies and some surface irregularities along the lower edges where there may be a slight drop to the river soils, the surface is naturally in good condition to receive water. A part of this type has begun to be damaged by seepage waters from higher levels, and such areas are now receiving an accumulation of alkali. The type, as a whole, however, lies at such an elevation that artificial drainage may be installed to carry off the surplus seepage.

Like the Billings fine sandy loam, the Billings clay loam is derived from the shale, sandstone, and mesa soils to the north, and is simply a finer deposit than the sandy loam laid down at lower levels. From indications in uncultivated areas, nearly the whole of the loam in the virgin state carried alkali in harmful quantities. This alkali, however, practically disappeared under culivation, and the soil was free until seepage water began to collect. The seepage areas are now affected with alkali and are constantly becoming more so as evaporation from the surface takes place.

Alfalfa, apples, pears, corn, and the grains are the principal crops grown. Apples and pears do well in the well-drained areas. Alfalfa is a decided success, yielding from 4 to 6 tons per acre in three cuttings. Wheat and oats give fair yields. Sugar beets are not extensively grown on this soil, but should prove to be very profitable. The Billings clay loam may be said to be well adapted to apples, pears, wheat, oats, corn, alfalfa, and sugar beets.

The following table shows the results of a mechanical analysis of a typical sample of the soil of this type:

Mechanical analysis of Billings clay loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
13432	Soil	0.1	0.3	0.2	1.7	6.2	43.8	47.4

BILLINGS SILT LOAM.

The Billings silt loam is a heavy, sticky, plastic silt loam of a light-gray to dark-brown color, from 3 to 6 feet deep, underlain by loam, clay loam, or clay. The soil becomes very hard when allowed to dry, and if cultivated in that condition breaks up into large clods, which weather into small cubes somewhat after the nature of adobe soils. In fact, the soil is locally known as adobe and possesses many of its characteristics. When moist, the soil has a slick, soapy feel, and if wet to saturation becomes very sticky. Great difficulty is experienced in cultivation to secure scouring of tools. The subsoil is usually of a darker color, contains more clay, and is yet more plastic than the surface soil.

The Billings silt loam usually occurs in rather large areas near the lower levels above the river soils. In one instance northeast of Grand Junction an area extends nearly to the foothills or mesa on the north of the valley.

The surface of the type is usually smooth and comparatively level, except for gullies and breaks along small bluffs cut by the river. Little labor is required to level for irrigation, and the fall is less than upon any other soil of the valley, with the possible exception of the Billings clay.

Since it occupies the lower levels and offers great resistance to percolating waters, much of the type has become water-logged through seepage. Especially is this true in the vicinity and east of the Indian school. Like the other soils of the Billings series the Billings silt loam has been derived from the shales, sandstones, and mesa soils to the north of the valley. It closely approaches a true alluvial soil, and can be best considered as such, being simply the finer particles of waste deposited from small, intermittent streams. Nearly all the silt loam now contains alkali in varying quantities. Those areas that have never been cultivated are more strongly impregnated than the irrigated ones. In all likelihood high percentages existed in all this soil before irrigation began.

The Billings silt loam is not generally considered a good soil for fruit, but if care is exercised in growing the trees, and if seepage be kept down, fair crops of apples and pears are secured. Alfalfa does fairly

well. Sugar beets are being grown in a small way and give good returns. Wheat and oats make fair yields. Sugar beets and alfalfa are the principal crops suited to the soil and should be grown wherever practicable. Well-established orchards should be greatly benefited by detailed drainage with tile or boards wherever water is less than 4 feet from the surface.

The following table gives the results of a mechanical analysis of a typical sample of this type of soil:

Mechanical analysis of Billings silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
13434	Soil	0.0	0.2	0.2	2.9	15.1	59.7	21.9

BILLINGS CLAY.

The Billings clay is a very stiff, heavy, sticky, gray to dark-brown clay loam, 4 to 6 feet or more in depth. Shallower areas are underlain by a sandy loam of the same characteristics as the material forming the Laurel sandy loam. The soil is very difficult to till, bakes and breaks into cubes when dry, and withal is most refractory. It is located at the lowest levels formed by the washes from the north of the valley and is composed of the finest particles of sediment brought down by them. Only a few areas of this type occur in the area surveyed.

The surface is in the main quite smooth and level. A few gullies and washes are the only departures from a uniform grade and these do not interfere with irrigation in any way. Because of its low-lying position much of the Billings clay suffers from a high water table or from seepage. Such areas, however, are usually so high above the present bed of the river that drainage would not be difficult.

This soil, like the others of the Billings series, comes from the sedimentary formations that lie north of the valley proper.

All the seepage areas and some other parts of the type with a fairly low water table suffer from an accumulation of alkali. In the seepage areas this condition is getting worse, but other areas by judicious flooding may be farmed and are improving. Artificial drainage should be installed in the seepage areas as soon as possible, to prevent further damage.

Grain, sugar beets, and alfalfa are the only crops grown with success on the Billings clay.

The following table gives the results of a mechanical analysis of a typical sample of this type of soil:

Mechanical analysis of Billings clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
13435	Soil	Tr.	0.1	Tr.	0.3	1.8	42.2	55.6

MESA FINE SANDY LOAM.

The Mesa fine sandy loam is a reddish to chocolate brown, light, friable, easily cultivated fine sandy loam, from 4 to 20 feet or more in depth, underlain by shale or sandstone which extends to undetermined depths. The shale subsoil is impregnated with alkali and when exposed the salts crystallize on the surface. The soil is loose and leachy and requires much water for irrigation. When thoroughly wet, however, the heavier areas are fairly retentive of moisture.

In a few isolated areas a sort of hardpan, locally known as "cement sand," exists at or near the surface. This hardpan softens upon the application of water and is of no serious consequence. Much of the Mesa fine sandy loam is very gravelly. While the gravel does not interfere with cultivation or impair materially the productiveness, it renders the soil more leachy, thus necessitating an additional quantity of water in irrigation. The Mesa fine sandy loam apparently extended at some past time across the valley. It now occupies the high level lands on both sides of the river, and no doubt represents a former flood plain. Much rounded gravel outcrops along the bluffs. These gravel particles are often cemented together to form a kind of conglomerate.

The topography of the type ranges from practically level mesa lands, through slightly undulating ridges, to rough, broken, hilly areas. Much of the land immediately along the valley proper, north and west of Grand Junction, and the bench lands on the south side of the river, west of Grand Junction, are sufficiently level to be easily irrigated if water can be supplied.

All of the Mesa fine sandy loam is leachy, and because of its high-lying position will always be well drained.

The soil has been formed at some past epoch by the river and other streams, which brought the material from high-lying sandstone, granitic, and volcanic regions. It has been subsequently somewhat modified by erosion and wind action.

Except for the underlying shale this soil is practically free from harmful quantities of alkali salts, and with ordinary care under irrigation should always remain so. The soil is deficient in organic matter, and if orchards or other tilled crops are to be grown it should be supplied by growing cover crops or applying stable manure.

Very little of the Mesa fine sandy loam is as yet under cultivation, but on Fruit Ridge and Orchard Mesa this type of soil supports some of the finest orchards in the valley. Alfalfa and truck crops are also a marked success. The soil is preeminently adapted to fruit and other tilled crops.

The following table gives the results of a mechanical analysis of a typical sample of this type of soil:

Mechanical analysis of Mesa fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
13429	Soil	0.4	1.3	3.1	18.3	21.1	31.1	24.5

MESA CLAY.

The Mesa clay is a sticky heavy clay loam or clay of a light grayish to dark slaty color, 1 to 6 feet or more in depth, underlain by shale. It is difficult to till and liable to bake, but when properly cultivated is rich and productive. It occupies a few small areas along the margin of hills in the eastern and central parts of the area and constitutes almost all the soil of the western part of the survey.

The topographic features of the Mesa clay range from slightly undulating and almost level plains to rough hills with almost perpendicular cliffs. Much of it is too rough for irrigation, but the large district in the west is well suited to irrigation farming and is very productive.

Throughout the Mesa clay spots have "gone to seep." This is so noticeable that many people in the valley stoutly aver that all the seepage land is due to shale in the subsoil. This seepage occurs in the shale lands principally where the underlying shale has forced the water near the surface. The topographic features of the type are such that it should be well drained, but when the water reaches the well-nigh impervious shale it follows it until it nears the surface, when the overlying soil often becomes swampy. In this way a hillside with steep slopes may become a marsh. This condition is more difficult to correct and presents a more complicated problem than the question of seepage in the areas where the damage is due wholly to a general rise of the water table. The subject will be more fully discussed under a separate heading.

The Mesa clay comes directly from the weathering of the underlying shale formation. In the deeper and more level areas the soil is partly colluvial, having received washings from surrounding areas of the same material.

The Mesa clay is principally devoted to beet culture. Some alfalfa and a little grain are grown, yielding fairly well. Tree fruits are not a success, except upon the deeper areas, and there only the hardier

apples and pears should be selected. The soil is well adapted to the growing of sugar beets and is a fair soil for alfalfa. Beets under good conditions yield from 10 to 25 tons per acre and alfalfa about 3 tons per acre from three cuttings.

The following table shows the results of a mechanical analysis of a typical sample of this type of soil:

Mechanical analysis of Mesa clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
13430	Soil	0.5	2.2	1.1	4.2	5.7	43.1	42.8

MESA CLAY LOAM.

The Mesa clay loam is a stiff, plastic reddish to chocolate-brown loam, difficult to cultivate and liable to bake when dry. It is 4 to 6 feet deep, usually underlain by sandy gravelly material, which, in turn, is underlain by shale or sandstone to undetermined depths.

The Mesa clay loam occurs in depressions, surrounded by Mesa fine sandy loam, and is composed mainly of the finer material of the sandy loam washed into these depressions. Nearly all the areas have a practically level surface, and require little or no leveling to prepare them for irrigation. The type lies mainly along the south side of Grand River on what is known as Orchard Mesa.

All the Mesa clay loam is practically free from alkali and, with ordinary care, will remain so. It is rich and productive, being especially adapted to the growing of alfalfa, sugar beets, and grain crops.

The following table gives an analysis of a sample of this soil:

Mechanical analysis of Mesa clay loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
13131	Soil	0.6	2.3	2.7	11.8	19.6	24.9	37.4

FRUITA FINE SANDY LOAM.

The Fruita fine sandy loam is a light to reddish-brown sandy loam, of medium to rather fine texture and 6 feet or more deep. The type shows throughout imperfect stratification, being composed of layers of almost pure sand alternating with those of loam and fine sandy loam. It is friable and easily cultivated, rarely proving refractory in tillage. In its virgin state there often occur smooth, slick looking places, where the soil particles are so cemented together as to be difficult to break. These spots are due to the presence of small amounts of black alkali, but upon irrigation they mostly disappear and give but little trouble.

The Fruita fine sandy loam occurs principally in a large area surrounding the town of Fruita. The surface is quite smooth, requiring very little leveling to prepare for irrigation. Several large washes have cut this area of the type. One of these just northwest of Fruita for a part of its distance has a width of one-eighth of a mile and a depth of about 25 feet. In this wash water now flows at all times, being supplied by seepage from surrounding lands.

Nothwithstanding that water passes readily through this soil and that the gullies offer excellent outlets for drainage, much of the type now suffers greatly from seepage. East and northeast of Fruita is a great apple district, where nearly all the trees are affected. If these orchards are to be saved, drainage must be accomplished soon. The washes and gullies will furnish excellent outlets and should be so utilized.

The Fruita fine sandy loam has been formed almost wholly from débris from the sandstone to the north of the valley and from washings from the Mesa fine sandy loam. The two large washes that traverse it have brought the soil to the valley and deposited it in a great alluvial fan across the plain. In its virgin state the soil contains less alkali than those of the Billings series. Wherever seepage is injuring the orchards or other crops alkali is accumulating, and unless the water table be lowered and constant care exercised in cultivation alkali will increase in quantity over the entire seepage area.

The Fruita fine sandy loam is an excellent fruit soil. Some of the finest apple and pear orchards of the valley are upon this type. It is in fact a good soil for almost any of the crops suited to the climate of the valley. Wherever drainage is good alfalfa, grain, sugar beets, and garden crops all do well. On the seepage areas, however, only grains, garden crops, and sugar beets succeed. Alfalfa and fruit trees are injured by the high water table. On lands not too badly affected by seepage sugar beets yield 10 to 20 tons, alfalfa 4 to 5 tons, wheat 15 to 40 bushels, and oats 40 to 60 bushels per acre.

The following table gives the results of a mechanical analysis of a typical sample of this type of soil:

Mechanical analysis of Fruita fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
13426	Soil	Trace.	1.2	2.1	24.2	26.9	34.6	10.9

FRUITA LOAM.

The Fruita loam is a reddish-brown, sticky, compact loam, 1 to 3 feet deep, underlain by a sandy loam similar in texture to the Fruita fine sandy loam. When dry it is very hard, breaks up in huge clods,

and shows a tendency to assume the cubical structure of the adobe soils. If stirred when moist it is not difficult to till, but care must be exercised to prevent packing and baking.

The type occupies the depressions and lower areas surrounded by the Fruita fine sandy loam, and is all found in the vicinity of Fruita. It is the poorest drained soil of the area. Practically all the orchards planted on this type have died, and now only annual crops and a little alfalfa are grown. Artificial drains should be installed.

This soil has the same origin as the Fruita fine sandy loam, and is merely the finer particles deposited in the lower places. Alkali has now begun to show on nearly all the Fruita loam, and with no betterment of the seepage condition this must steadily grow worse.

If well drained the Fruita loam would be a good fruit soil, but in its present condition it is suitable only for annual crops, such as sugar beets and the grains.

The following table gives the average results of mechanical analyses of this type of soil:

Mechanical analyses of Fruita loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
13423, 13424	Soil	0.1	1.1	3.5	16.6	17.6	38.4	22.6
13425	Subsoil	Trace.	.1	.1	1.7	6.4	65.0	26.5

HARDPAN.

Strictly speaking, there is no hardpan in the area mapped, but throughout the valley and occasionally upon the mesa lands a hard formation is often encountered at or near the surface which is locally known as "cement sand" or "cement." These places are probably caused by the presence of a small amount of sodium carbonate or black alkali, which salt has a peculiar puddling effect upon the soil. It is very difficult to get these spots to take water, but when once thoroughly wet they soon disappear, the cementing salts being washed out by the irrigating water. The spots are so small and of such a local character that no attempt was made to outline them upon the maps.

In parts of the Mesa clay the shale comes close to the surface, and there forms an almost impervious subsoil. This high shale subsoil is sometimes referred to as a hardpan, but it is simply the material from which the overlying soil has been formed.

On Orchard Mesa, south of the river from Grand Junction, the gravel subsoil is sometimes cemented together to form a sort of hardpan, but these areas are small and practically negligible. On the whole, the valley is practically free from injurious areas of hardpan.

ALKALI IN SOILS.

Alkali occurs in patches throughout the valley proper, and in the shale soils wherever found. The largest areas are in the vicinity of Grand Junction. Almost every tract of virgin soil in the valley proper shows quite marked accumulations, so that in all likelihood much of the valley now producing good crops carried an excess of salts before irrigation. A road or fence line is often the boundary between good lands producing crops and virgin lands having more than 1 per cent of alkali. Wherever the shale which underlies the sandstone formation is exposed alkali effloresces on the surface. The percentage carried by this rock is often not very high, but is quite sufficient to account for the alkali of the valley. All the soils that in their virgin state contain alkali have been formed in part or wholly from this shale.

On the seepage lands, where alkali is now accumulating, the salts come from the seepage water which has leached through the alkali-impregnated soils and subsoils of the valley. A small proportion of the alkali may come from the disintegration of the soil, but the major part comes originally from the salts of the shale.

The following table gives the composition of the alkali occurring in the soils:

Chemical analysis of alkali crusts.

Constituent.	No. 43. 2-40, S. 24, T. 1 S., R. 2 W.	No. 59. 7-40, S. 15, T. 1 S., R. 1 W.	Constituent.	No. 43. 2-40, S. 24, T. 1 S., R. 2 W.	No. 59. 7-40, S. 15, T. 1 S., R. 1 W.
Ions:	*Per cent.*	*Per cent.*	Theoretical combinations—Continued.	*Per cent.*	*Per cent.*
Calcium (Ca)	6.53	3.83	Magnesium chloride ($MgCl_2$).	11.91	18.40
Magnesium (Mg)	3.04	3.71	Sodium chloride (NaCl)	33.72	35.22
Sodium (Na)	21.86	24.17	Potassium chloride (KCl).	1.74	1.50
Potassium (K)	.92	.86	Sodium bicarbonate ($NaHCO_3$).	1.92	.53
Sulphuric acid (SO_4)	11.01	45.04	Sodium nitrate ($NaNO_3$)	29.75	....
Chloride (Cl)	35.55	21.99	Sodium sulphate (Na_2SO_4).	....	31.33
Bicarbonic acid (HCO_3)	1.40	.40	Soluble salts	12.2	28.5
Nitric acid (NO_3)	21.69	Trace.			
Theoretical combinations:					
Calcium sulphate ($CaSO_4$).	15.60	13.02			
Calcium chloride ($CaCl_2$)	5.36	....			

The alkali in the soils prior to irrigation was pretty evenly distributed throughout the soil column, as is shown by borings upon areas of virgin soil north and east of Grand Junction. In the seepage areas upon lands which were once free from alkali the accumulation since irrigation is principally at or near the surface, rarely extending in quantity below 3 feet.

RECLAMATION OF ALKALI LANDS.

Experience has shown that irrigation alone, upon the lands having good drainage, is sufficient to free the soil and reclaim the lands so that useful crops can be grown. In this area a line fence often divides two fields, one of which has virgin soil containing 1 to 3 per cent of alkali and the other irrigated and supporting excellent crops of alfalfa with less than 0.20 per cent of alkali in the soil. On all the well-drained lands the early settlers paid no attention whatever to the alkali, but took strongly impregnated lands and by irrigation alone soon so sweetened them that tree fruits and alfalfa were profitable crops. Irrigation and cultivation are all that is necessary to reclaim any of the highlands found north and east of Grand Junction. Because of the generally well-drained condition of the valley at the time of its settlement and the consequent ease with which the alkali then present in such quantities was removed, the settlers were blinded to the necessity for safeguarding themselves against damage from this ever-present evil in all irrigated countries. When the water table rose to such a height that evaporation took place from the surface, and alkali therefore accumulated, there were few that had the proper knowledge of the subject to combat the conditions arising. A few have successfully drained their land and have thus saved valuable orchards. The expense, however, is great, and but few of the farmers who have seepage lands and have experienced a few years of poor crops can secure the funds for this expense.

Northwest or west of Grand Junction, near the town limits, there is a tract of about 200 acres of Laurel sandy loam, at one time highly productive, that is now practically a swamp and white with alkali. This soil is an excellent one for truck crops, and its close proximity to the town should insure a ready market for all such crops as could be grown. The owners have tried individually to check the seepage, but because of lack of the concerted action needed to install a comprehensive drainage system, their efforts have been entirely unsuccessful.

With the abundance of available irrigation water and the high prices of land there is not an acre of alkali land in the valley that can not be successfully and economically reclaimed.

Much money has been uselessly expended on poor and inadequate drainage. The installation of drains in these lands should never be attempted without the supervision of a competent engineer. Drains unless properly laid soon become inoperative and represent a dead loss. If properly installed, drains would not need to be at very frequent intervals, for over the greater part of the valley the soils are porous and drains should draw for quite a distance on each side. Experiment can best determine the detail necessary to use in installing drainage. When sufficiently drained, the same method that freed the soil of alkali when it was first cultivated will again bring it into a condition to produce paying crops.

UNDERGROUND AND SEEPAGE WATERS.

Practically none of the underground waters of the valley are used either for drinking purposes or for irrigation. Cisterns supplied from the ditches or water hauled from the river furnish the supply for domestic use. Well water is all considered too salty for drinking purposes. In fact, practically no wells exist in the valley.

Perhaps no subject is at present so vital to the farmers of the valley as the seepage problem. Starting in the low places and along the slopes below canals, seepage areas have gradually spread until now many hundreds of acres are in a fair way to become valueless, unless radical changes are introduced in the methods of dealing with the evil. Among the farmers and real-estate dealers many and conflicting opinions as to the cause of the seepage are expressed and almost as many remedies suggested. It seems under the circumstances to be well to consider the causes under two heads, viz, seepage caused from lateral percolation from canals and seepage due to a general rise of the ground water from excessive irrigation.

For the greater part of its course the high lateral of the Grand Valley Canal follows along the edge of the mesa lands that bound the valley proper on the north. In many places it cuts across points of the mesa, and lands below have a steep slope for several hundred yards. Wherever the underlying material is impervious, as where the canal cuts the underlying shale or where the slope below is steep, the soil immediately below the canal or at the point of the outcropping of the shale is seepy. Throughout the area of Mesa clay this seepage from lateral percolation is marked, and numberless small areas testify to the gravity of the problem. Often the seepage occurs on steep slopes, and in no case can it be traced to a general rise of the ground water. The remedy that naturally suggests itself is to cut off the underground flow above the point of seepage. This is a very difficult thing to do, as the surface of the underlying impervious shale is very irregular and broken. Ditching to cut off the underflow can often be done only at a greater expense than can be borne by the affected lands. The only way to determine the feasibility of such ditching is by careful surveys and prospecting to ascertain the amount of ditching necessary to tap the underflow.

By far the greater part of the damage from seepage in the valley, however, comes from the general rise in the ground water. The water that causes the rise comes partly from seepage, but mainly from excessive irrigation. Practically all the damage in the large area affected east and north of Fruita has been caused by the use of excessive amounts of water. The soil allows the ready penetration of water, which after the subsoil is once filled must pass laterally through the soil until it reaches some outlet. Soils that would other-

wise be well drained are in this way permanently water-logged. As soon as seepage has filled the soil and subsoil with water constant evaporation from the surface has caused the accumulation of alkali to begin, which tends further to injure the crops. It is not easy to separate the two evils, but it is fair to say that the seepage alone practically ruins the land for all tree crops. Alfalfa will struggle along for some time, but eventually must succumb. The total damage from seepage and its attendant accumulation of alkali has been enormous, and the evil is spreading. If the high-line canal should ever go through to irrigate the high-lying mesa lands, the problem will become even more serious than it is at present.

It is safe to say that there is a sure remedy for all lands that are injured from a gradual rise of the water table. The river and the gullies cut through the valley are at a sufficient level below the affected lands to insure good outlets for drains. Drains placed at sufficient intervals to lower the water table to a depth of 5 or 6 feet would not be prohibitory in cost at the present price of land. After such drains are installed care will have to be exercised to prevent evaporation from the surface, but this can be done and the lands kept in a productive state. Wherever possible occasional surface floodings should be made to wash into the drains any alkali that may have accumulated at the surface.

WATER SUPPLY FOR IRRIGATION.

The supply of water for irrigation practically all comes from the Grand River. A small area on the south side of this river just west of its junction with the Gunnison River is supplied from a pumping plant from the latter. It is planned also to irrigate some of the bench lands west of this point with water from the same stream. All the remainder of the valley draws its water from Grand River. The supply greatly exceeds the present demand and doubtless will always be greater than can be used by the valley. At the present time there is rarely, even in the lowest period, less than 1,000 second-feet passing the head gate of the Grand Valley Canal, the only gravity ditch of any consequence now diverting water from this stream. Above the Grand Valley Canal, at the extreme eastern end of the valley, are the headworks of two pump ditches where water is raised 34 and 80½ feet, respectively, for the Palisades and Spur ditches. These ditches supply water to about 10,000 acres of land in the vicinity of Palisades that is above the gravity canal.

South of the river two pump ditches supply several hundred acres on Orchard Mesa. These pumps as well as those at Palisades are run by water power, which is not expensive. The ditches on Orchard Mesa are private ones. Palisades Ditch costs for maintenance about 75 cents per acre. The original cost of this ditch was $75,000, for

which the district was bonded, the interest on bonds being an additional levy. Near where the Gunnison flows into the Grand River there is a pumping plant that takes water from the former stream to supply lands south of the Grand River and west of Gunnison. Along the river there are a number of water wheels that raise water for small tracts, and across the Grand River almost south of Fruita is a small ditch that irrigates a few farms on river-bottom lands.

Water stocks and rates are remarkably cheap under the present only large ditch of the valley. Water stocks sell for $25 per inch, an inch being used for 2 acres. Considering the cost in other districts of the West this is remarkably low.

Quite a number of plans to irrigate lands on Orchard Mesa have been brought forth, and from time to time parts of ditches have been constructed, but all these have now been abandoned except the two ditches above mentioned.

All irrigation in the valley, either proposed or now operative, means the use of the waters of the Grand or the Gunnison River, which contain no deleterious salts or other substances in quantities that will ever be injurious.

AGRICULTURAL METHODS.

Practically the same methods are pursued in the growing of all the various tree fruits of the valley. The first step is to sow the land to grain or other annual crop for one or two seasons, during which time it is heavily irrigated to induce rapid settling. Peaches are most extensively planted, principally the Elberta variety. The trees are set at different distances, varying from rows 16 feet apart with 12-foot intervals between trees in the row to 24 feet apart each way. Experience has demonstrated that in this valley the peach tree is long lived and may grow to be a very large tree and yet preserve its full vitality. The most noticeable thing in the older orchards is the crowding that is taking place. Ten-year-old trees should be not less than 25 feet apart, and in many cases would do better if they were 30 feet apart. After the young trees are set out they are irrigated each summer from May to September, inclusive. No winter irrigation is practiced. A few fruit growers plant truck crops, corn, or potatoes in the spaces between young trees. Others cultivate only a small strip along the row and leave the middles to grow up to weeds. The majority, however, cultivate the entire surface of the field, which is left fallow and irrigated in three or four furrows between each row of trees. If the irrigation is extended to three or four furrows so as to wet the entire soil, the method of cultivating the entire space and growing no crops is no doubt the best. However, if fertilized, there seems no reason why truck crops should not be grown in the spaces between the trees, as this method insures thorough wetting of the ground and also

affords substantial returns during the unproductive state of the orchard. When the trees come into bearing no crops except cover crops for fertilization should be grown. Irrigation for large trees should be from not less than three furrows between the rows of trees, and preferably from four or five. A few fruit growers depend upon only one small furrow on each side of the tree for moisture. This practice tends to induce bunching of the roots so that the trees do not draw from the entire area allotted to them. All irrigation in the orchards is by the furrow method. This method, with careful cultivation and the rainfall of the valley, has so far proved successful and is no doubt the best way to apply the water.

The apple, pear, prune, cherry, and apricot trees are planted and cultivated in much the same way as peaches. Prune, cherry, and pear trees are set a little closer, as a rule, than the peach trees, while apples are set farther apart. A general criticism of all the orchards of the valley might be made, however, of the closeness with which the trees are set. Almost every orchard of any age shows crowding. On the Fruita fine sandy loam some orchards that have begun to suffer from alkali due to seepage would be greatly benefited by a heavy flooding. This should be done late in the fall or in early spring, so as to lessen the liability of the soil to bake. Cultivation should take place as soon as possible after the flooding. Such a flooding once a year or every six months should prevent an accumulation of alkali and greatly prolong the life of the trees.

Practically no fertilization has yet taken place in the valley, except from barnyard manure and cover crops. This season (1905) the fruit exchange at Grand Junction brought in a carload of commercial fertilizer, which was distributed among the farmers to be used more as an experiment than to supply any pressing need.

Alfalfa is sown either with or without grain as a catch crop. Contrary to the usual rule in irrigated regions both grain and alfalfa are partially furrow irrigated. Small furrows, or "creases," as they are called, are made across the field, usually with the maximum slope, about 2 to 4 feet apart. The water from the head ditch is turned into these small furrows and the soil between is moistened by lateral percolation. For some of the heavier soils, which are very liable to bake, this method is a good one, but for the sandier soils or those containing much alkali flooding in checks or from small ditches made through the fields can not fail to give better satisfaction. Besides being a nuisance at harvest time, the furrow method of irrigation tends to concentrate the alkali in the ridges between the furrows, so that in many cases the only place where crops are growing is in the furrows, where the alkali has been washed out by flooding. In grain and alfalfa growing the greatest room for improvement is in generally substituting flooding for the method of "creasing."

Alfalfa is usually allowed to stand until blooming is about over before being cut. This makes the hay very woody and stiff and much less nutritious than when cut in the early bloom stage.

Wheat, oats, and other grains are cut by self-binders and thrashed either from the shock or stacked to await the coming of the thrasher.

Sugar beets are sown with beet drills in early May. Usually it is necessary to irrigate to bring the seed up. Furrows are made in alternate spaces between the rows through which water is allowed to flow. Two rows are thus irrigated from one furrow. After coming up the beets are usually hoed twice, cultivated twice, and irrigated with sufficient frequency to insure favorable moisture conditions. Upon maturity the beets are plowed out, topped, and hauled to the nearest railway station, where the beet-sugar company of Grand Junction receives them.

Truck crops, small fruits, berries, corn, and potatoes are grown in many small fields throughout the valley. The methods employed in cultivating these crops vary with almost every individual grower. The majority, however, are successful, and the valley, as a whole, has a growing business along these lines.

AGRICULTURAL CONDITIONS.

The farming classes of the Grand Valley are, as a rule, in a remarkably prosperous condition. A mortgage foreclosure is an almost unheard-of thing. The peach growers near Palisades have had an unbroken series of good crops that have brought them from $100 to $500 per acre net. These lands have advanced in value by leaps and bounds until now there is hardly any land in what is popularly known as "the peach belt" that can be bought for less than $500 an acre. The apple growers are only slightly less prosperous than the peach growers.

Alfalfa and grain growers are prosperous and secure good prices for their products. Alfalfa produces from 4 to 6 tons of hay per acre, and brings from $7 to $10 a ton. Vegetables and small fruits find a ready sale, and those engaged in the production of such crops are succeeding. The sugar-beet industry has been a boon to those owning land not suited to fruit or truck, and the growers of this crop are also prospering.

The farms are nearly all owned by the men who work them. No considerable proprietary holdings exist, except for three or four thousand acres owned by the beet-sugar company. Farms range in size from small 5-acre tracts, cultivated to fruit or truck, to 160 acres.

During the fruit picking and packing season much labor is hired. Women and girls of the valley do most of the packing, while the picking is done mostly by transient laborers who annually come to the valley during this season. Cultivation and irrigation are principally done by the farmers themselves, with occasional help of men

hired by the month. These monthly laborers come mostly from the Middle Western States and are usually young men who expect themselves to become landholders. This class of labor is very efficient.

The work required in the growing, harvesting, and thrashing of grain and in the growing and harvesting of alfalfa is also principally done by the farmers and the monthly laborers.

The hand work in the beet fields is done principally by Russian families who contract to do the hoeing, thinning, and topping for $20 an acre. The team work is done by the growers themselves.

Grand Valley fruit is well known and has a wide popularity. The peaches are of excellent quality and usually bring the highest market prices. The apples and pears are of good quality and find a ready sale. A good quality of oats and wheat is produced. The sugar beets have a high sugar content, and the yields are large. Alfalfa hay, because of the custom of cutting after most of the blooming is done, is of an inferior quality, but this can be remedied by earlier cutting. Vegetables and small fruits and berries are of an excellent quality.

The Laurel fine sand and Laurel sandy loam are the recognized truck soils of the valley. Upon the Billings fine sandy loam most of the peaches are grown, although the Mesa fine sandy loam should prove an excellent soil for this crop. Apples of excellent quality are grown on Fruit Ridge in great quantities, the soil here being the Mesa fine sandy loam. The Billings clay loam, Billings silt loam, and Billings clay are recognized as alfalfa, grain, and sugar-beet lands. The Mesa clay is best adapted to sugar beets, and most of the beets of the valley are now grown upon this soil.

The Rio Grande and Western and Colorado Midland railroads run into the valley. The Colorado Midland runs over the tracks of the Denver and Rio Grande. The main line of this road from Denver to Salt Lake City traverses the valley from east to west. From Grand Junction a narrow-gauge branch of the Denver and Rio Grande runs over the mountains to Ouray, Montrose, Delta, and other towns, connecting with the main line again at Salida. A narrow-gauge road runs from Grand Junction north to the Bookcliffe Range, a distance of about 12 miles, where are located extensive coal mines. Some complaint is heard about freight rates, but the majority seem to think there is no unfair discrimination.

The wagon roads of the valley are poor. Little interest seems to be taken in the subject of good roads. A little thorough grading should, however, put the roads in good condition and greatly add to their value to the county as a whole.

For many years the fruits of the valley found their principal markets in mining towns and less favored districts of the State. Recently, however, the fruit associations and cooperative marketing concerns

have been shipping fruit to far-distant markets. Now the principal peach markets are Missouri River towns, and during the season of 1904 some peaches were shipped as far east as Boston with gratifying results. Apples are largely sold in the State, although many are shipped west, southern California furnishing an excellent market. Other fruits and vegetables are mostly sold to mining towns and cities within the State. The alfalfa is nearly all consumed in the valley. The fruit growers afford an excellent home market for this product. The sugar beets are all used by the local factory and bring a flat price of $5 a ton.

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U.S. DEPT. OF AGRICULTURE
BUREAU OF SOILS
MILTON WHITNEY, CHIEF.

ALKALI MAP

COLORADO
GRAND JUNCTION SHEET

Alkali surveyed by
Garnett Holmes and Thomas D. Rice
1905

Scale 1 inch - 1 mile

Field Operations
Bureau of Soils
1905.